Project # CS-1114A-99
University of Florida

Jennifer Jacobs → watershed hydrology

Suresh Rao (Purdue Univ.) → vadose zone hydrology

Debbie Miller → vegetation ecology

George Tanner → vegetation ecology

Bill DeBusk (PI) → soil biogeochemistry

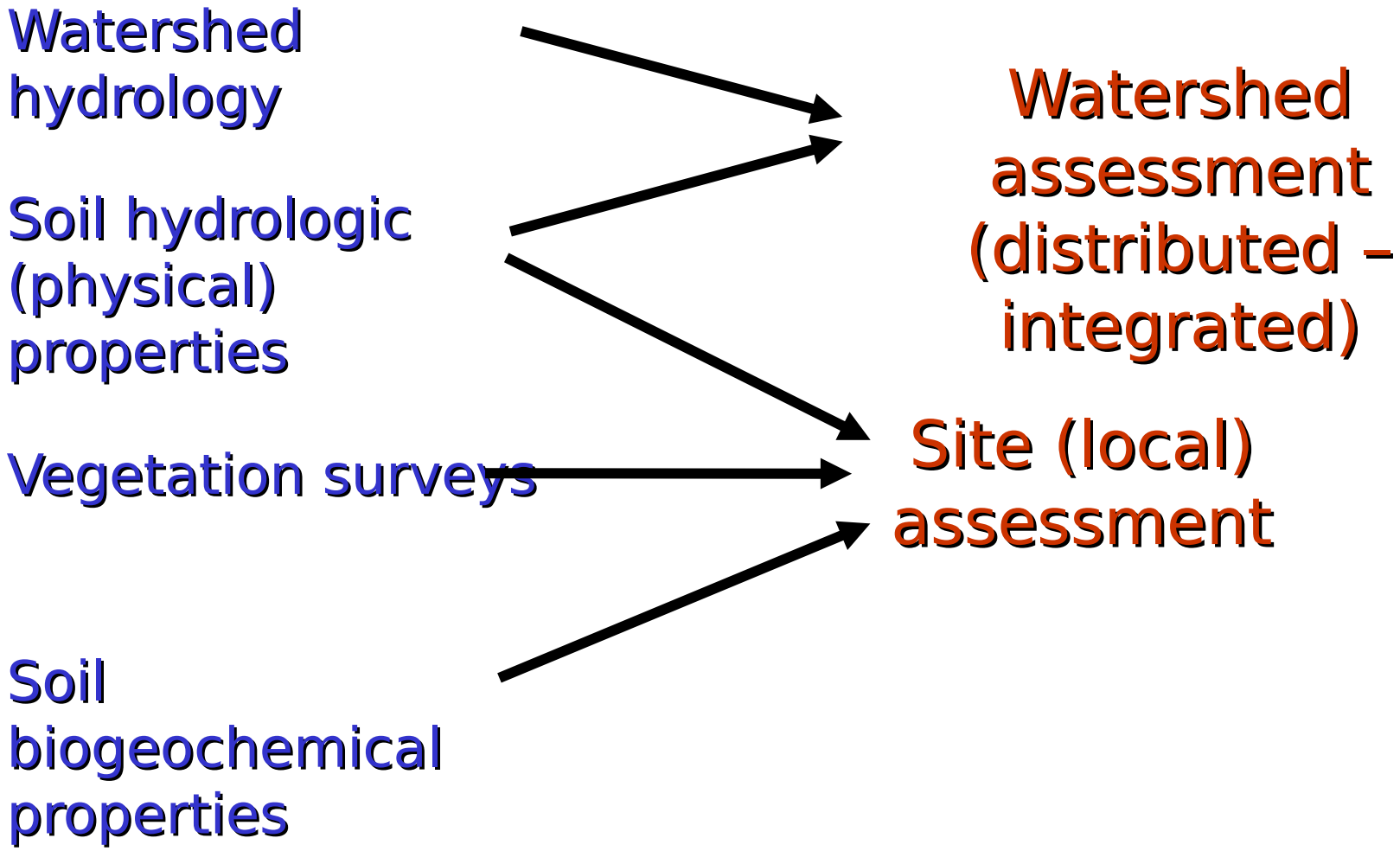
Ramesh Reddy → soil biogeochemistry

Joe Prenger → soil microbial ecology, enzymes

Andy Ogram → soil microbial ecology, functional diversity

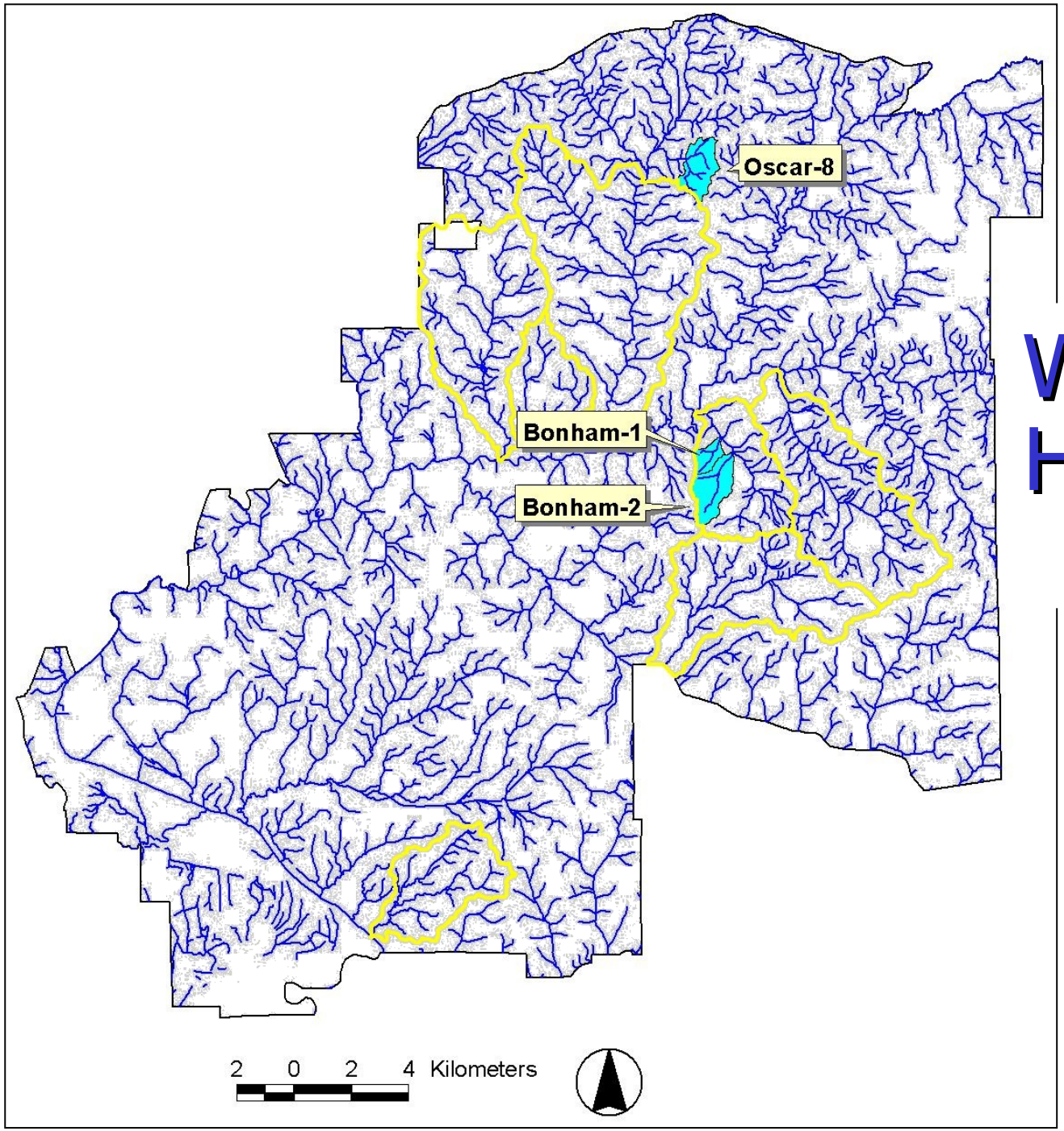
Wendy Graham → spatio-temporal analysis

RESEARCH APPROACH



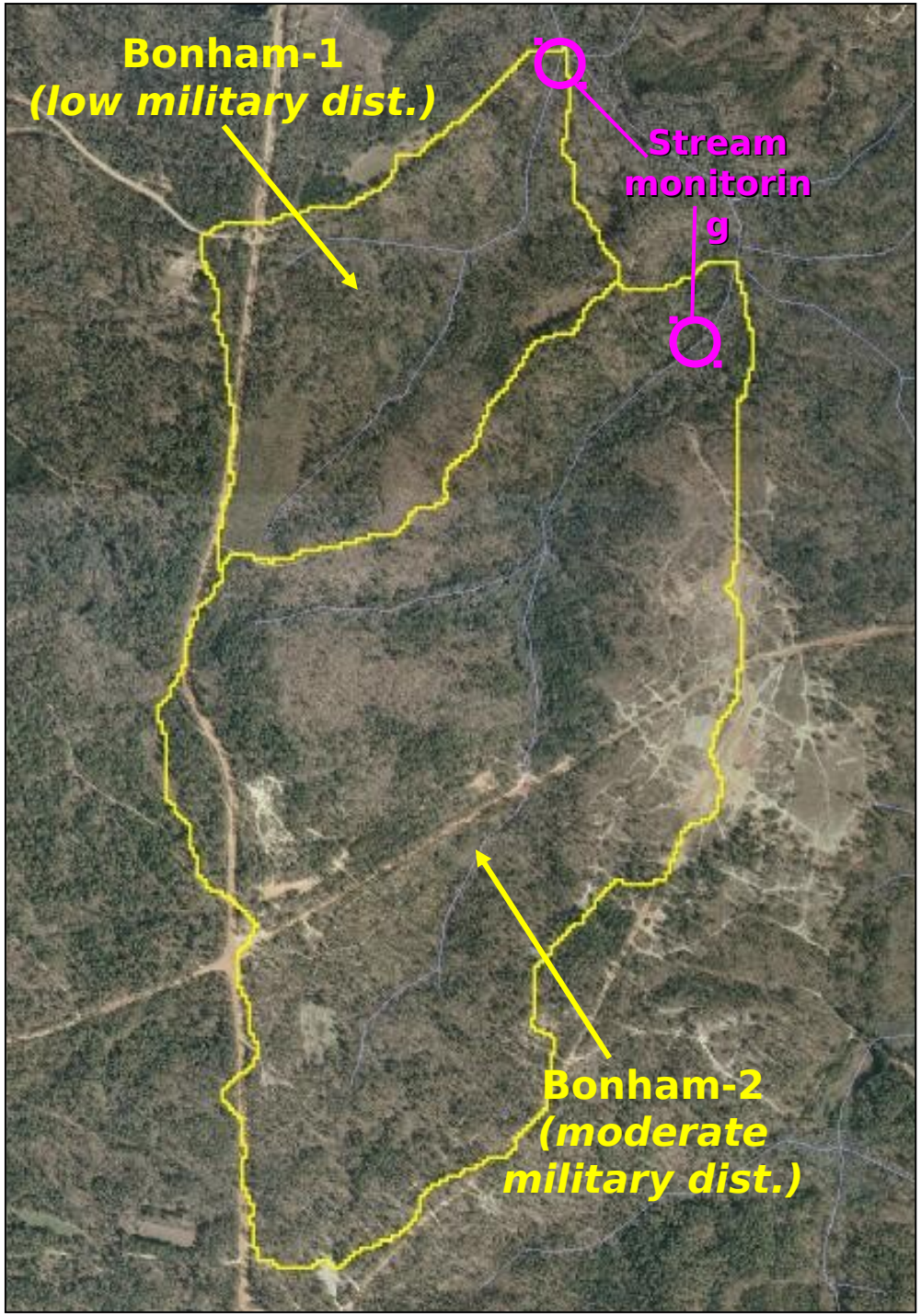
WATERSHED HYDROLOGY

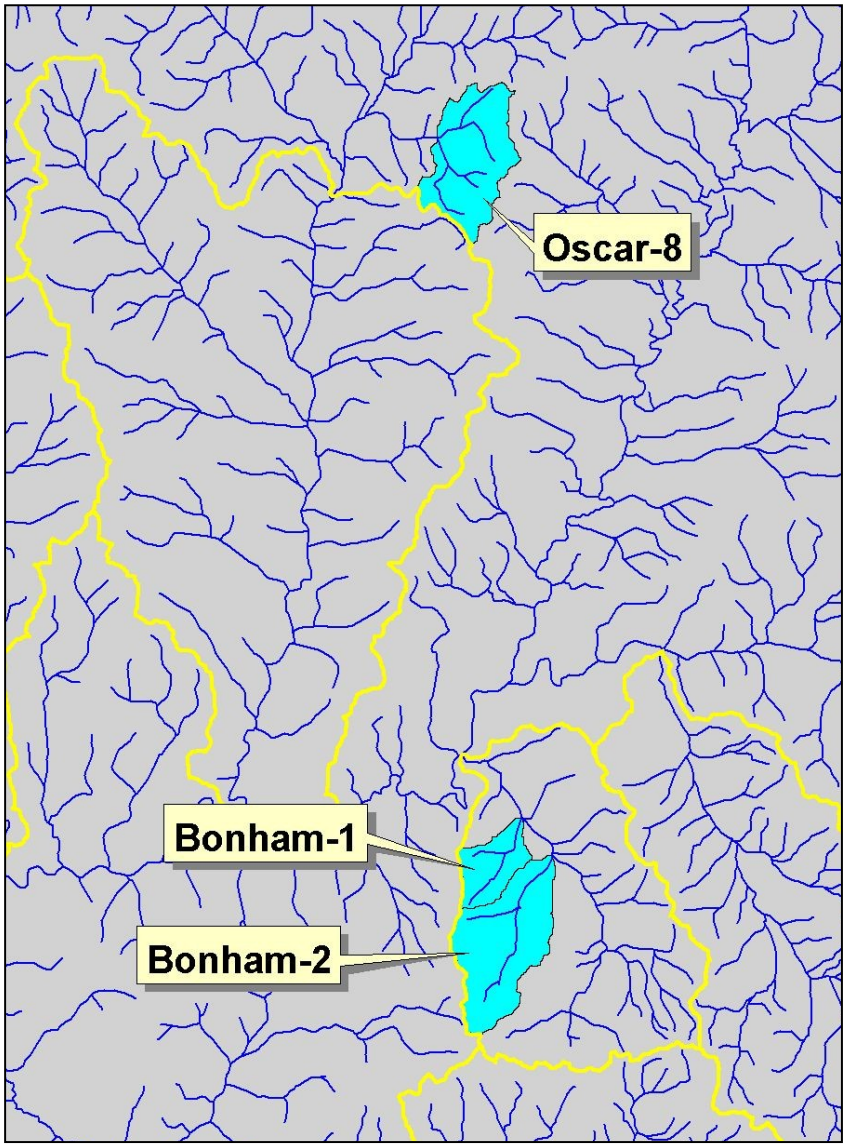
- Stream monitoring
  - Stage / discharge
  - Water quality (Hydrolab and stream sampling)
- Canopy throughfall / interception
- Flow routing, water budget
- Watershed modeling



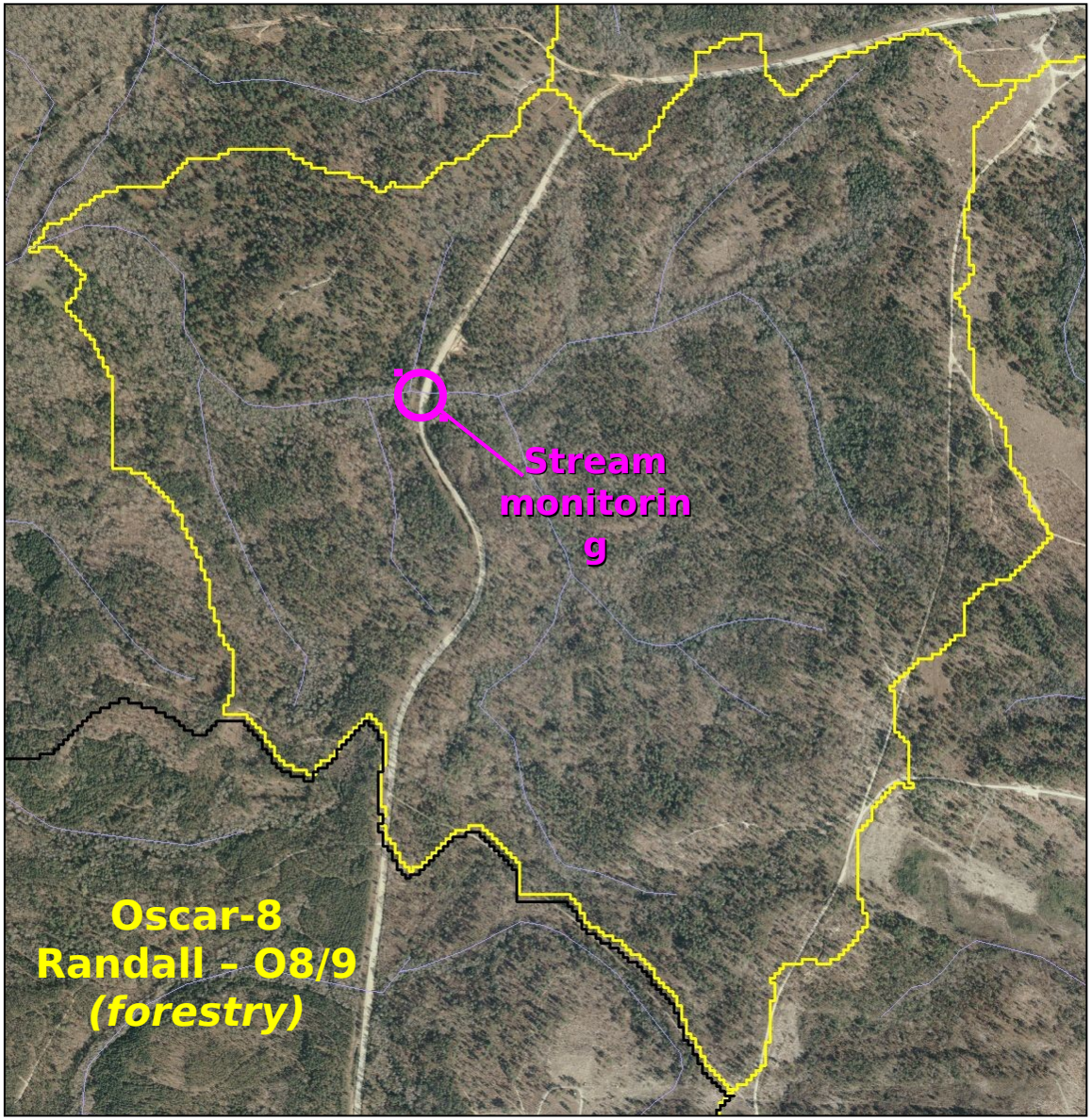
WATERSHED HYDROLOGY SITES

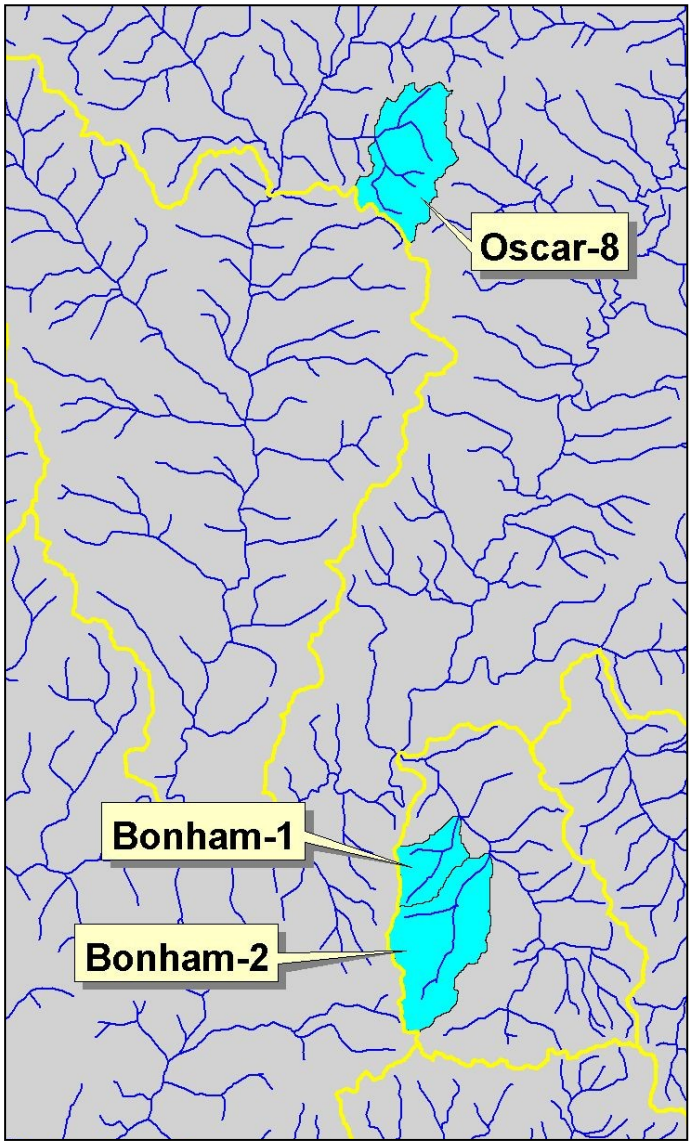
WATERSHED HYDROLOGY





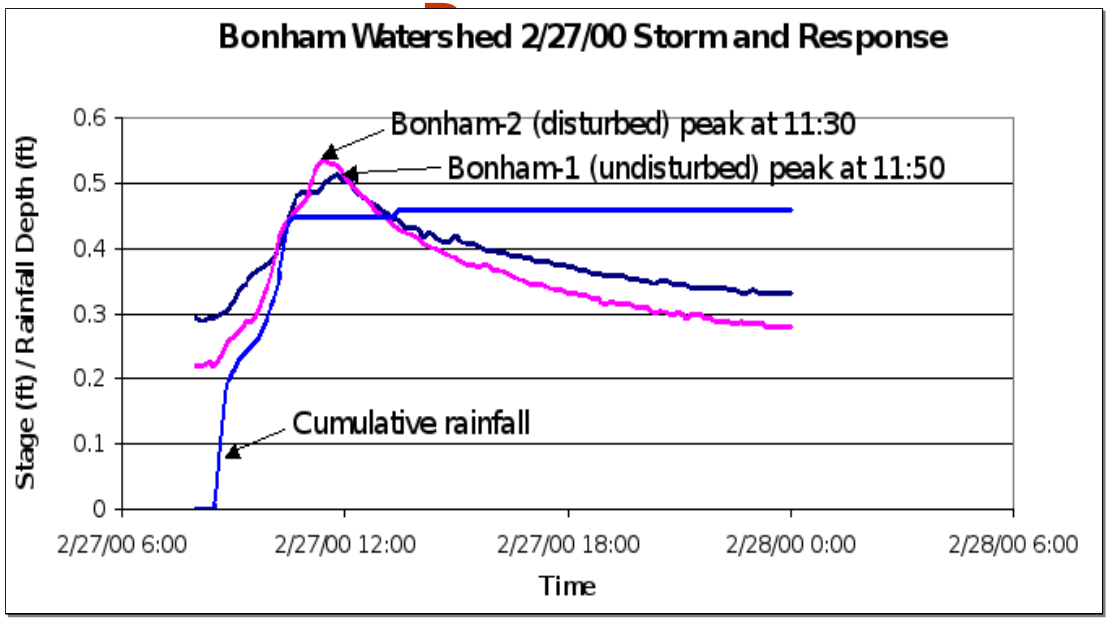
WATERSHED HYDROLOGY

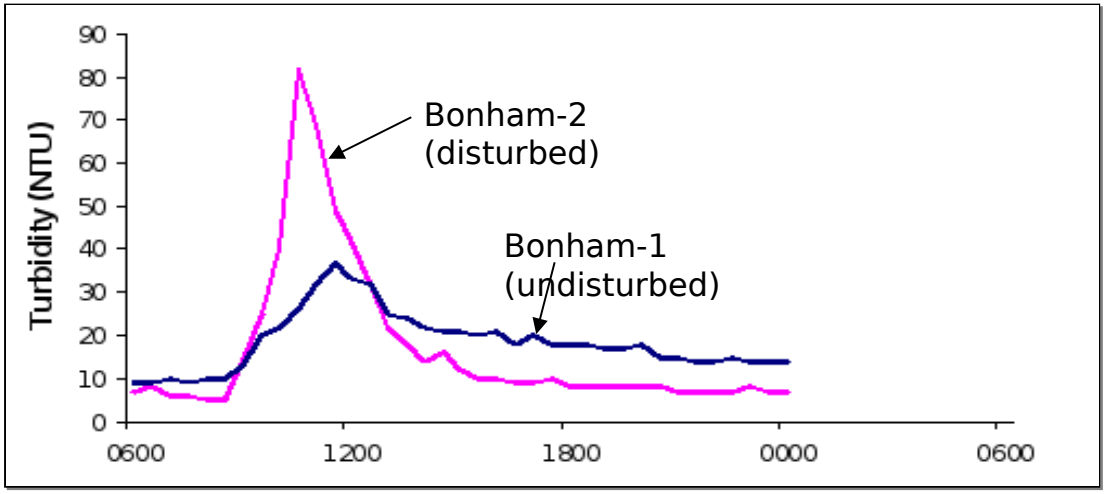




WATERSHED HYDROLOGY

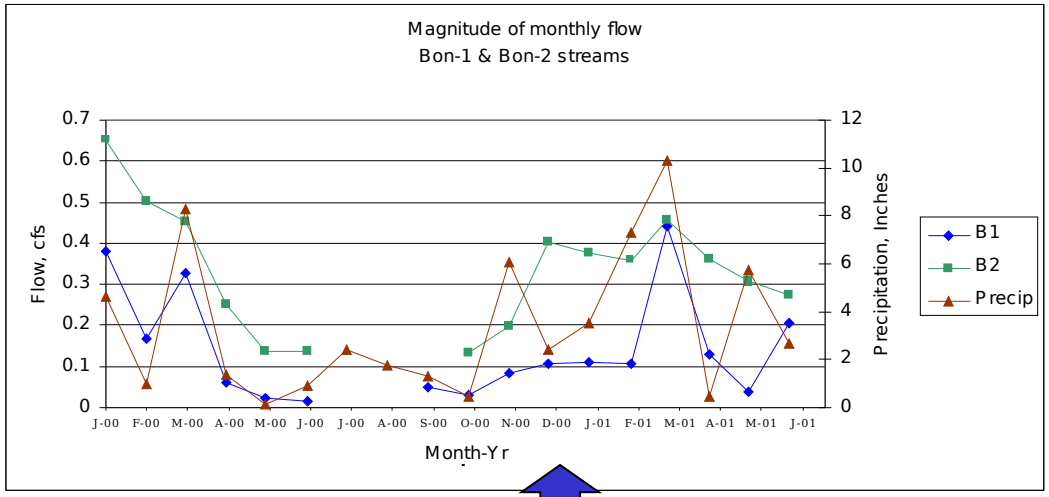
Stream monitoring – Event



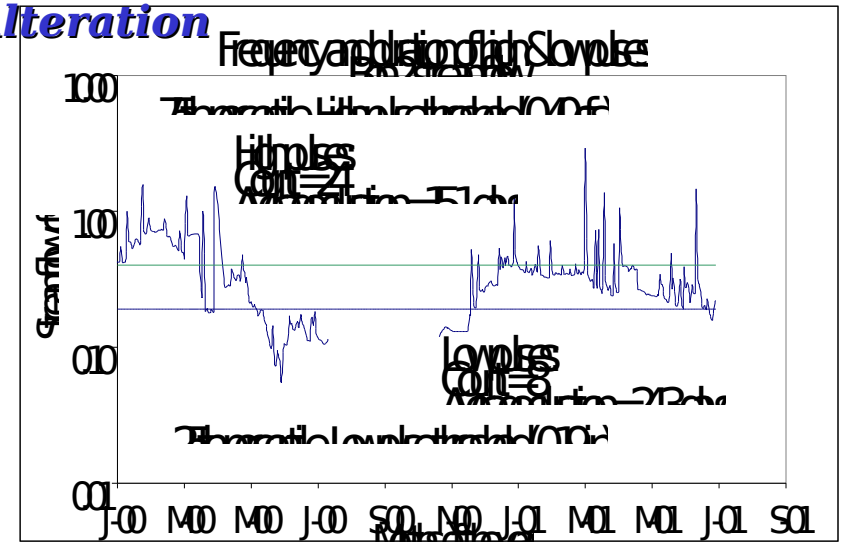


WATERSHED HYDROLOGY

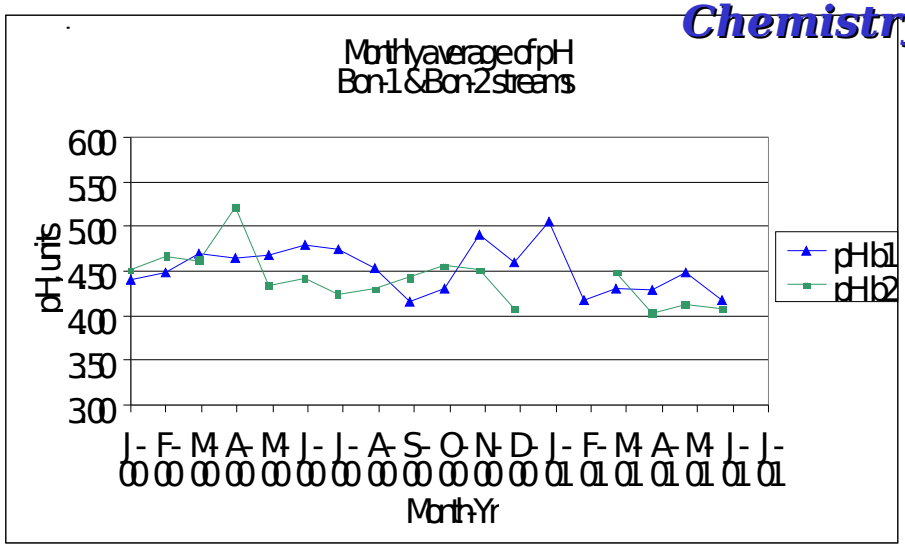
Stream monitoring – Annual



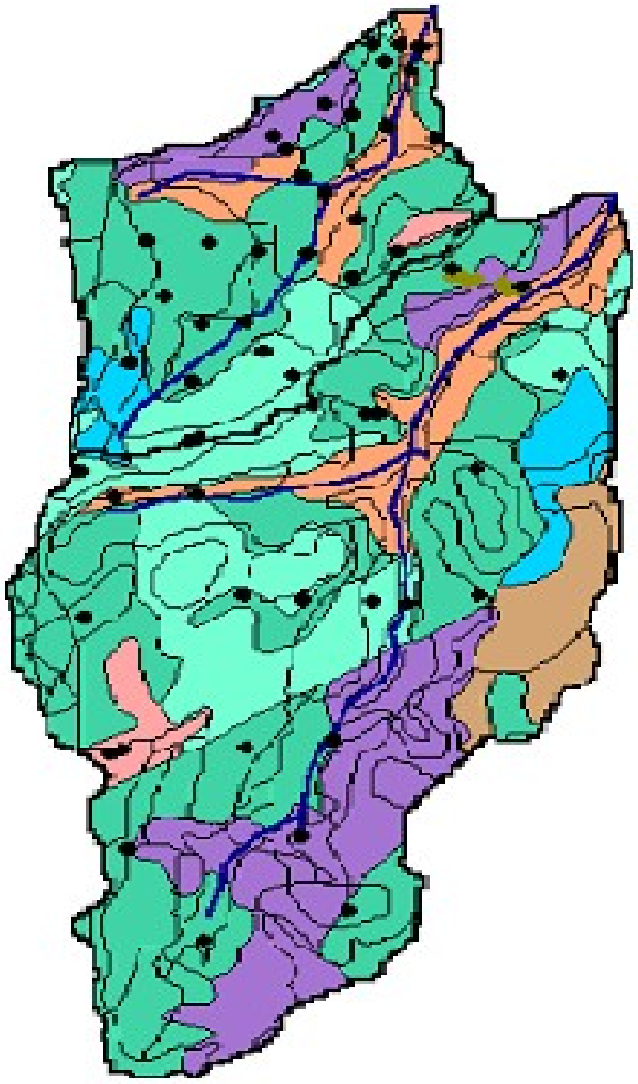
Indicators of Hydrological Alteration



Comparison of Stream Water Chemistry



WATERSHED HYDROLOGY



Canopy throughfall collection

Measures precipitation available for infiltration and runoff

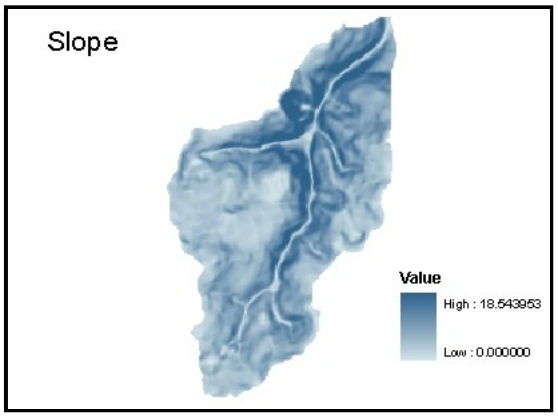
WATERSHED HYDROLOGY

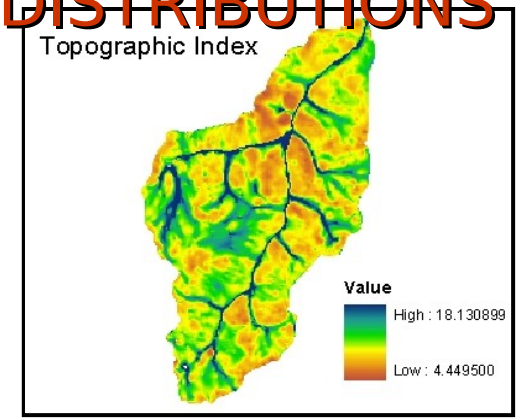
Canopy interception

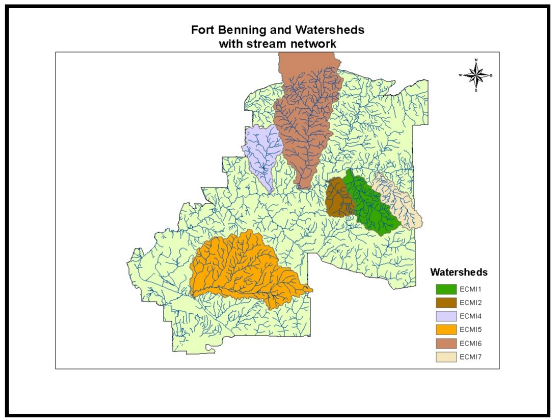
- Important parameter for watershed models
- Preliminary analysis shows a relationship between throughfall and gross storm precipitation based on land cover
- These relationships will be formalized to develop a spatially-distributed predictive model of canopy interception
- Preliminary results for pine forests indicate that the Gash-Rutter model provides reasonable results

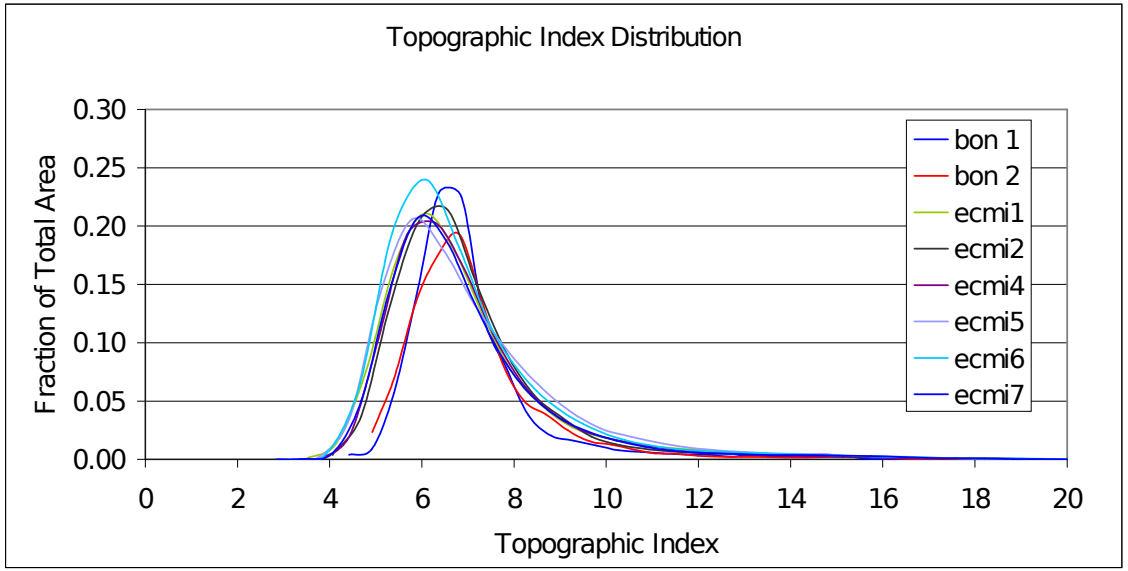
REGIONAL WATERSHED INTERCOMPARISON

PHYSIOGRAPHY AND TOPOGRAPHIC INDEX DISTRIBUTIONS









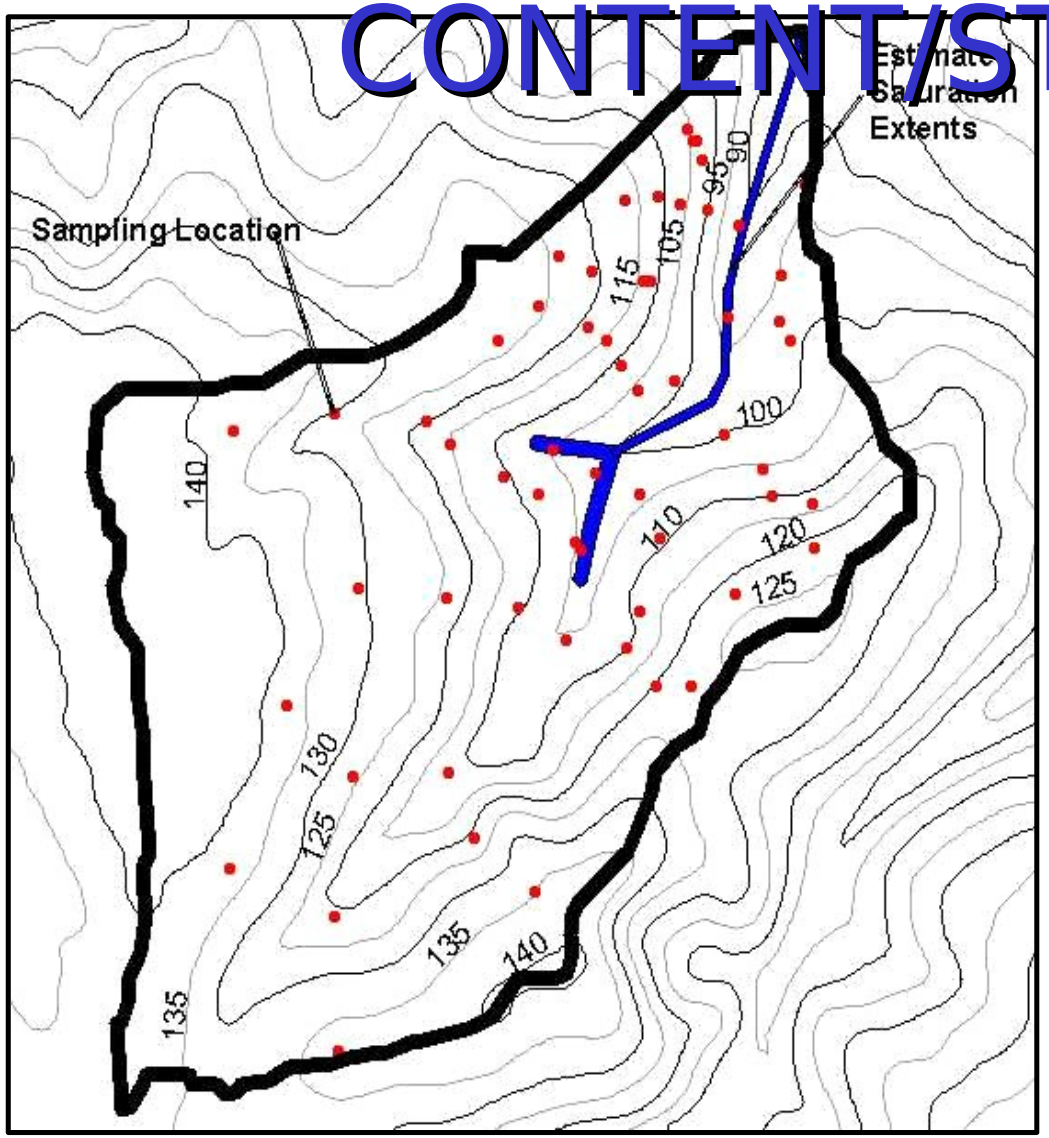
SOIL HYDROLOGIC PROPERTIES

- Soil texture, bulk density
  - Relate to erosion, deposition, compaction
- Permeability (infiltration rate)
- Runoff characteristics – surface / subsurface flow
- Soil-water content / storage

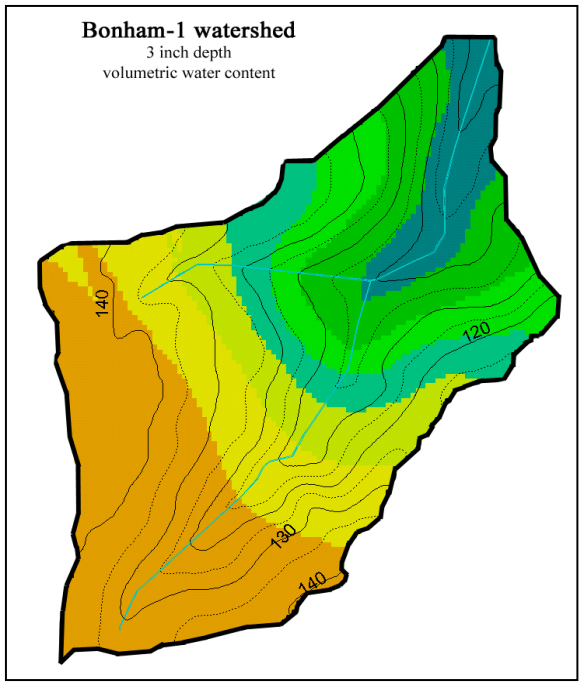
SOIL WATER CONTENT/STORAGE

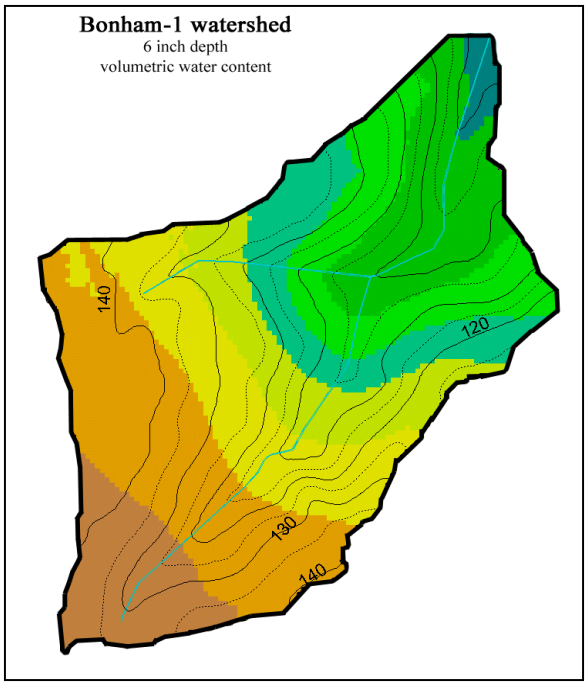
- Spatial/temporal changes in soil water storage
- Comparison of high-low disturbance watersheds
- Estimate total water storage and spatial moments of water content within the catchment using an unbiased (e.g. kriging) geostatistical model
- Soil moisture data compared to stream gauge data to relate distributed storage dynamics to in-stream response

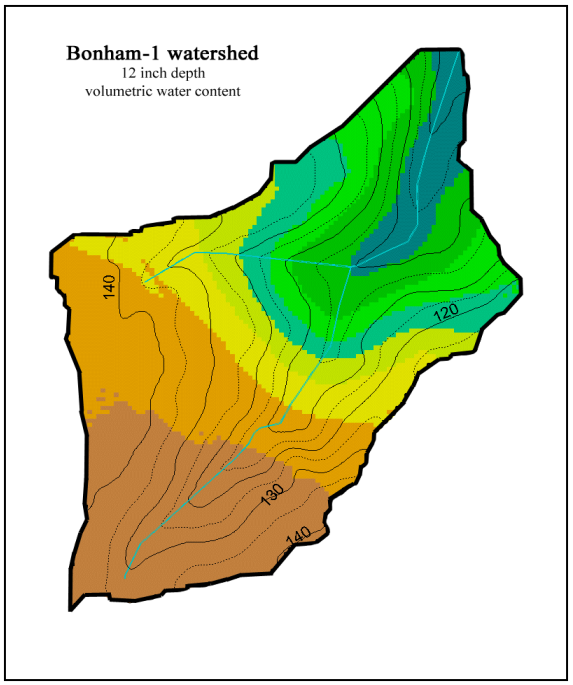
SOIL WATER CONTENT/STORAGE

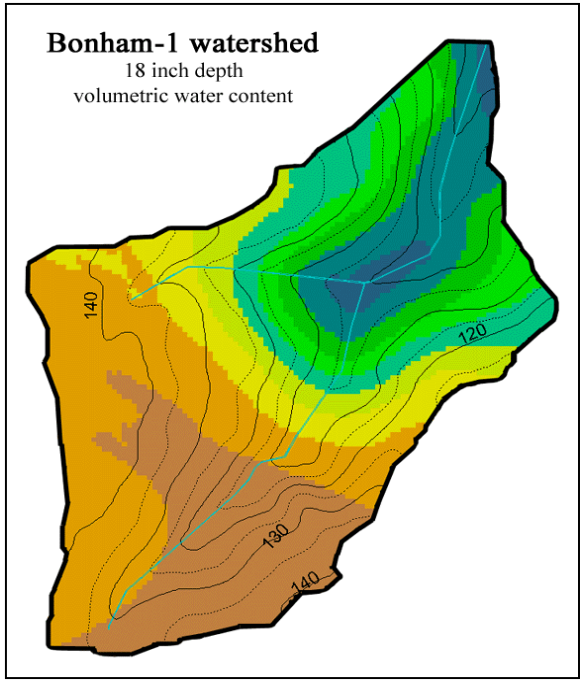


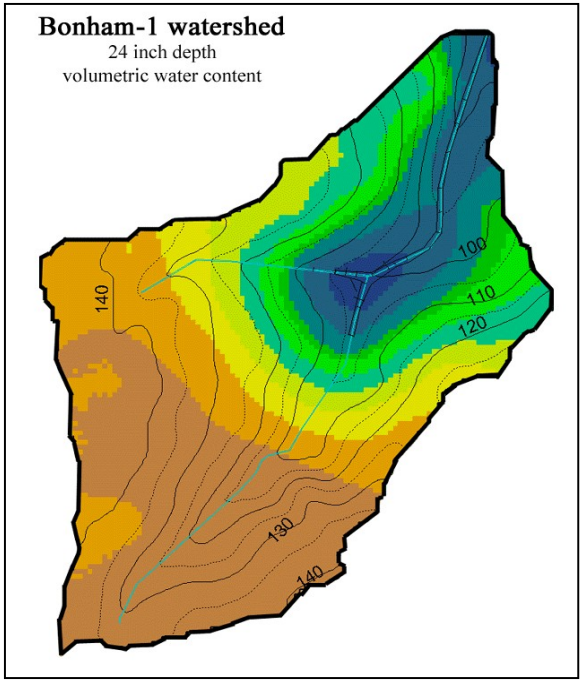
70 sampling locations in D13 catchment (Bonham-1 watershed)









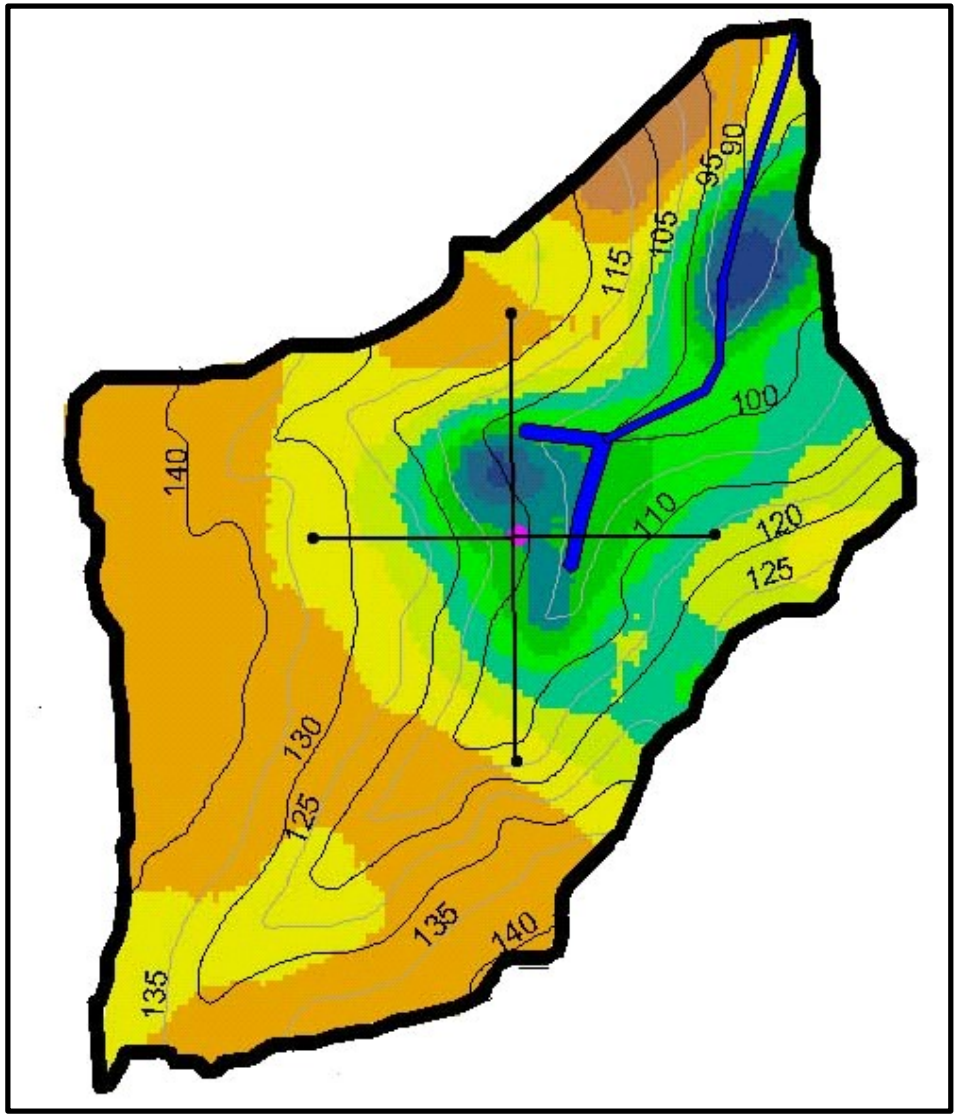


SOIL WATER CONTENT

June 2001

Volumteric Water Content

- 0.14 - 0.18
- 0.18 - 0.22
- 0.22 - 0.26
- 0.26 - 0.3
- 0.3 - 0.34
- 0.34 - 0.38
- 0.38 - 0.42
- 0.42 - 0.46
- 0.46 - 0.5



SOIL WATER CONTENT

August 2001

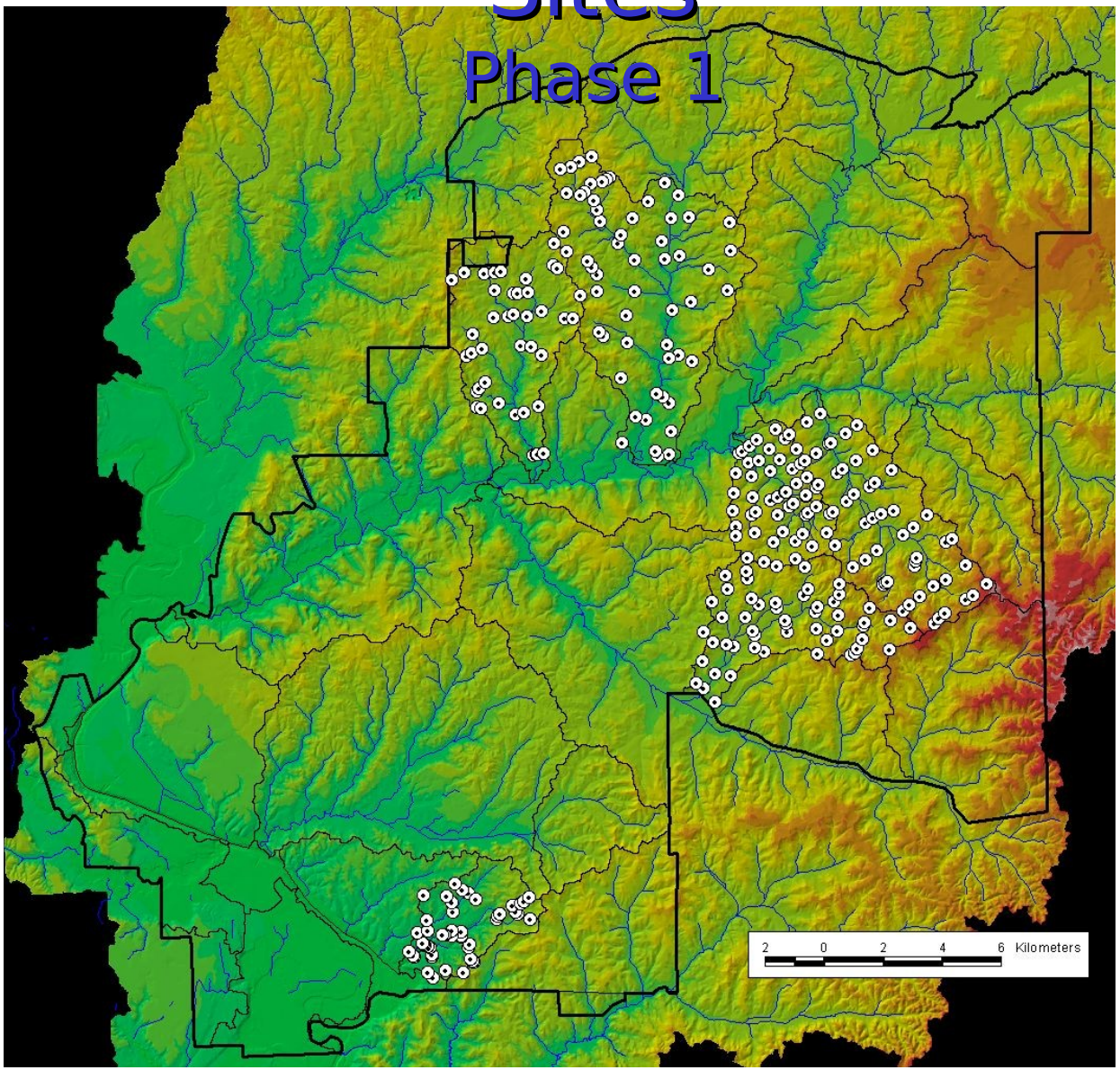
Spatial Moment Summary

	w/o Stream Zone	w/ Stream Zone
Total Water (m3)	38,896	42,880
Centroid - x (m)	710,313	710,330
Centroid - y (m)	3,588,465	3,588,488
Centroid - z (in)	13	13
stddev - x (m)	251	247
stddev - y (m)	274	276
stddev - z (in)	9	9

Total Volume (m3)	580,710	
Average Water Content	0.067	0.074

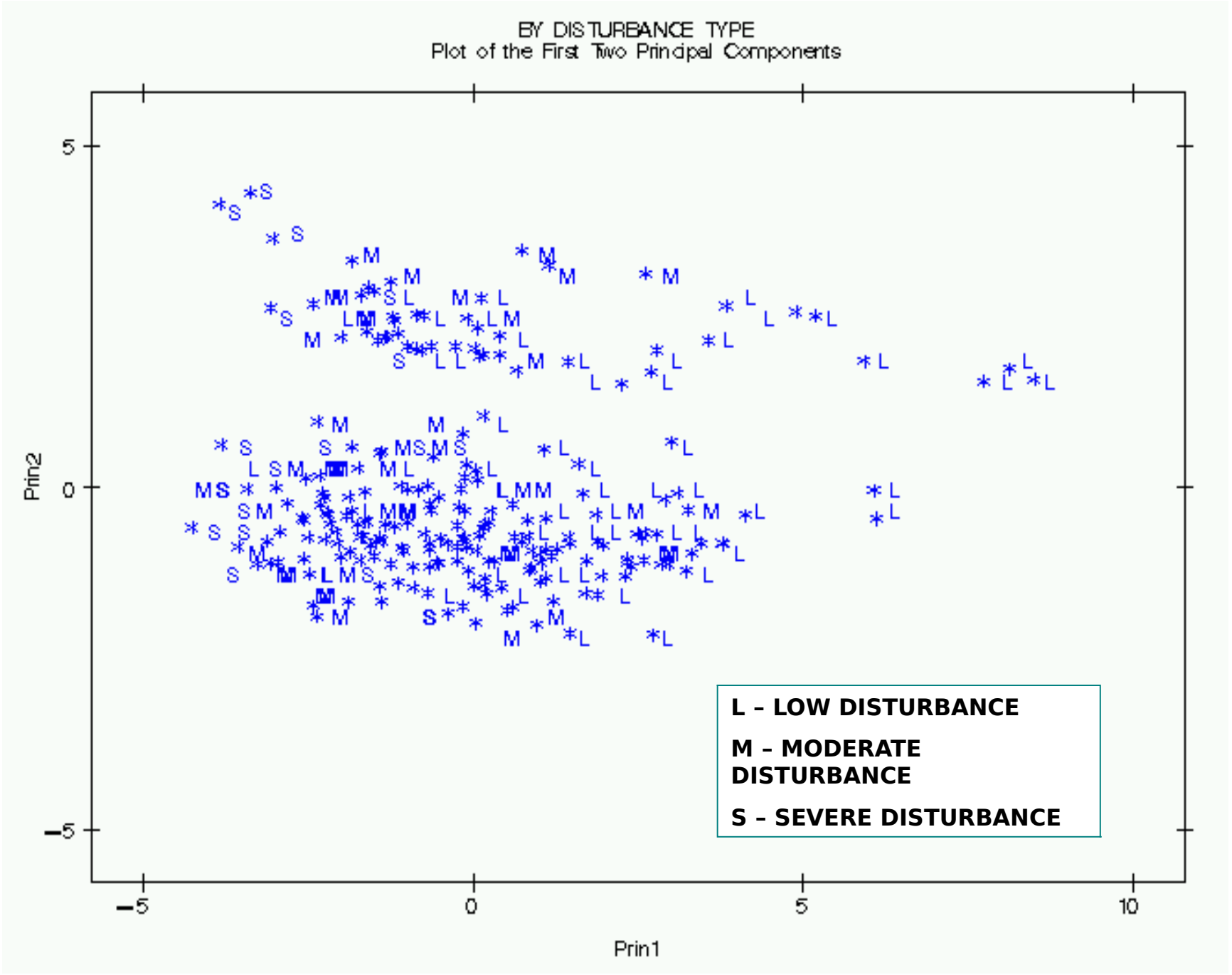
Soil & Vegetation Sites

Phase 1

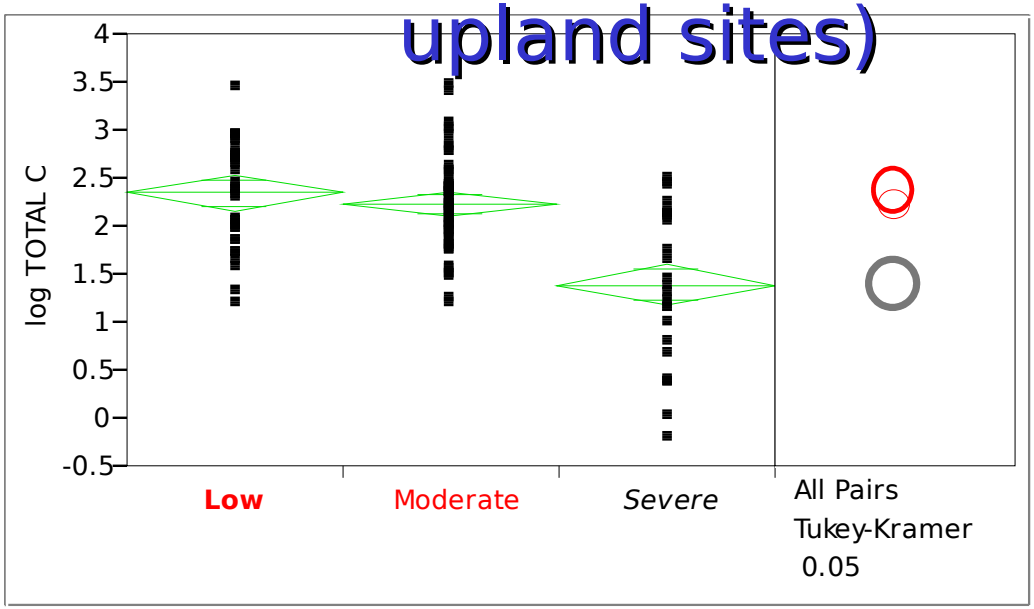


Soil Biogeochemistry

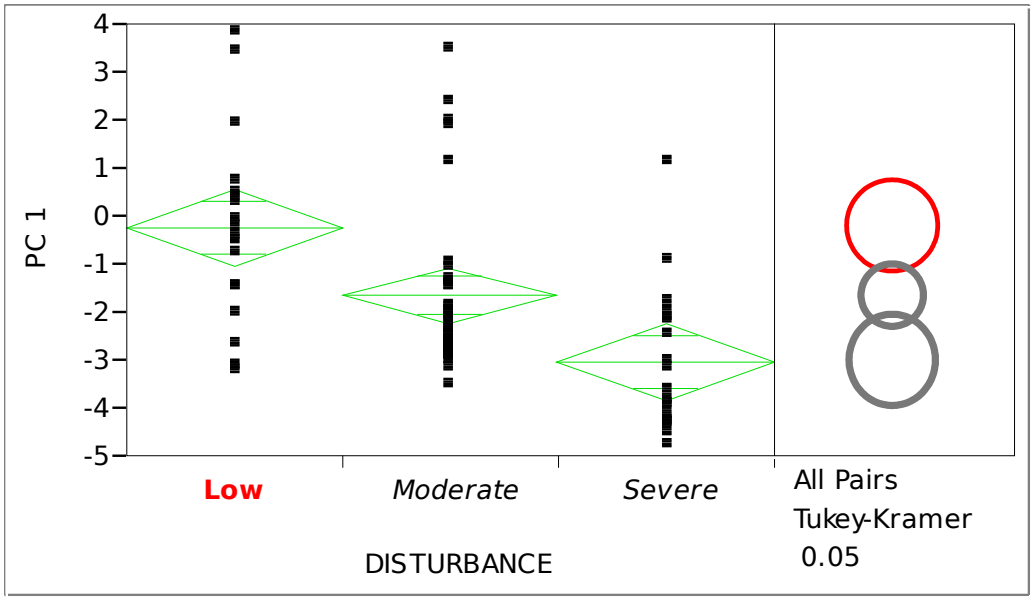
pH
Total C Water Extractable C Microbial C Soil respiration (CO_2 prod.)
Total N Exchangeable NH_4^+ Microbial N PMN Arginine ammonification
Total P Water Extractable P HCl Extractable P Oxalate Extractable P Mehlich-1 P Microbial P
Mehlich-Fe, Al, Ca, Mg, K Oxalate-Fe, Al
Acid Phosphatase Beta-Glucosidase Dehydrogenase Protease Microbial diversity


BY DISTURBANCE TYPE
Plot of the First Two Principal Components
Prin2
Prin1
5
0
−5
−5
0
5
10
L – LOW DISTURBANCE
M – MODERATE DISTURBANCE
S – SEVERE DISTURBANCE

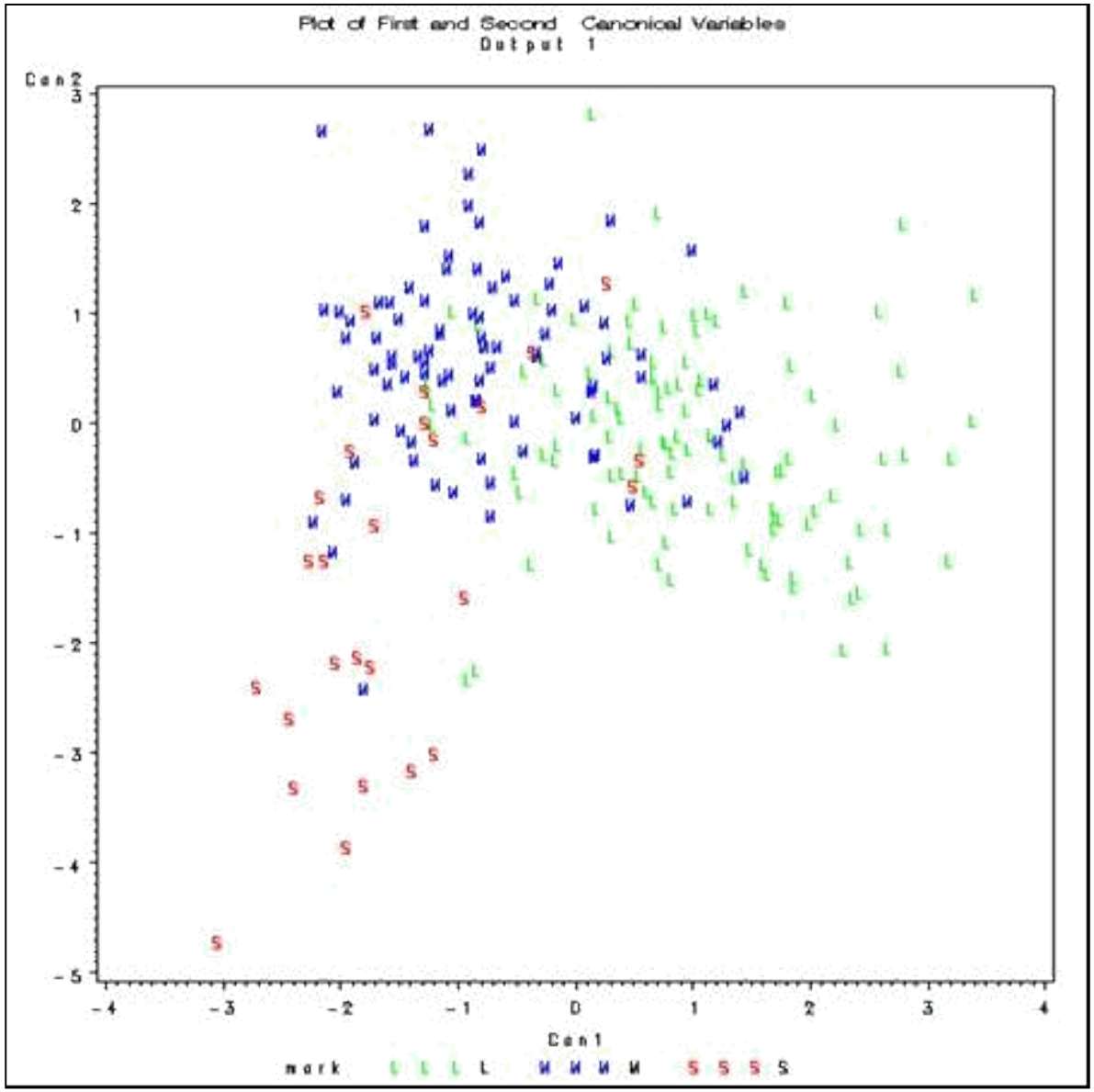
SOIL BIOGEOCHEMISTRY (Phase 1 upland sites)



Total C (log)



Prin. component 1



SOILS PHASE 1: CANONICAL DISCRIMINANT ANALYSIS

Disturbance Class

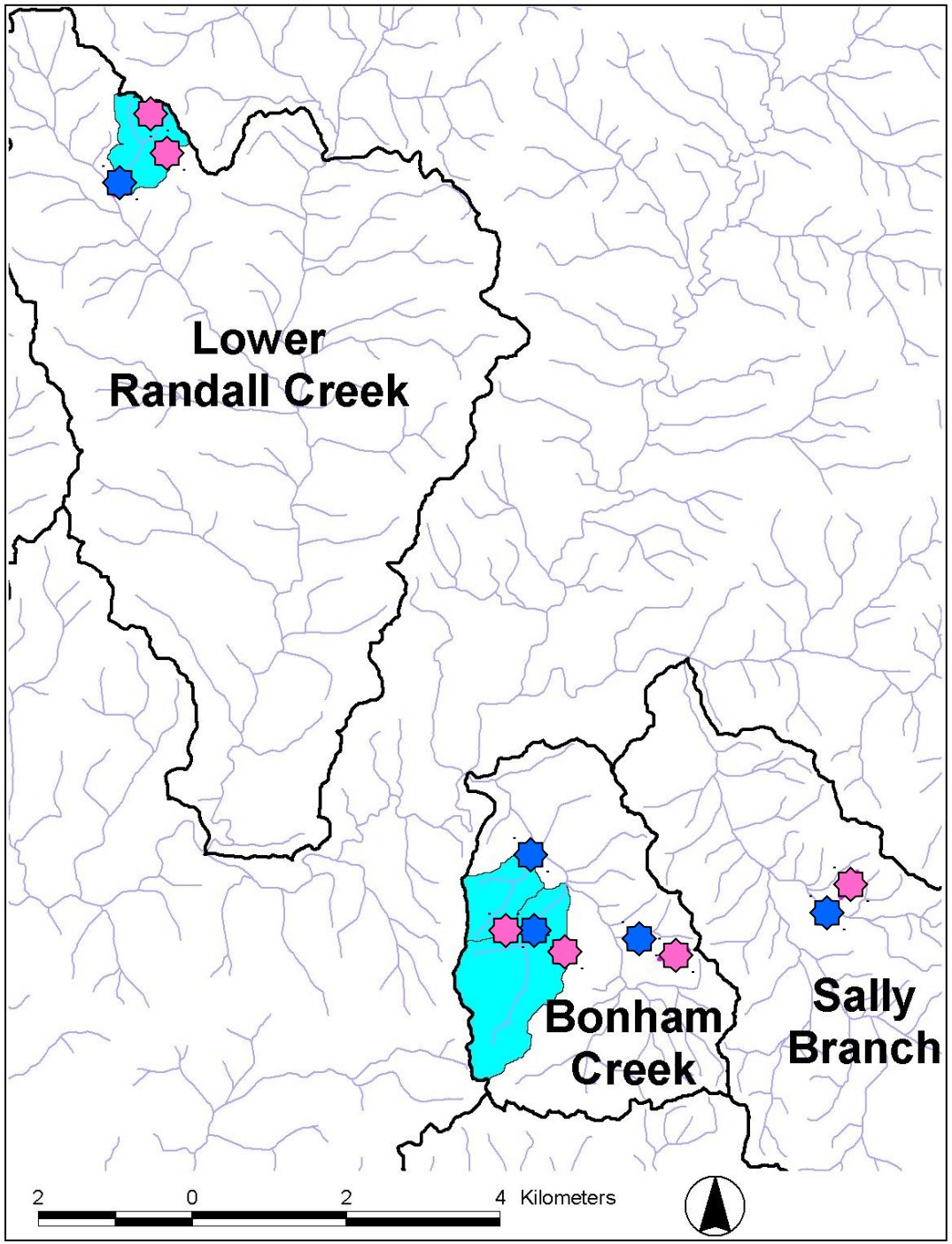
L = low

M = moderate

S = severe

SOIL BIOGEOCHEMISTRY

- Uplands
  - Disturbance or loss of A horizon
  - Loss of organic C and associated nutrients
  - Change in partitioning of organic C between labile (e.g. plant fragments) and resistant (e.g. humus) fractions
  - Change in relative C availability and soil “ecological stability”
- Wetlands
  - Sedimentation – clay, silt, sand
  - Burial of organic soil
  - “Dilution” of organic matter content
  - Increase in inorganic Fe and Al



SOIL / VEGETATION TRANSECT SAMPLING (Phase 2)

- Upland area (200-400m length)
  - –Troup loamy sands
- Wetlands (80-100m length)
  - –Bibb soil series
- Sampled @ 20m (typical)

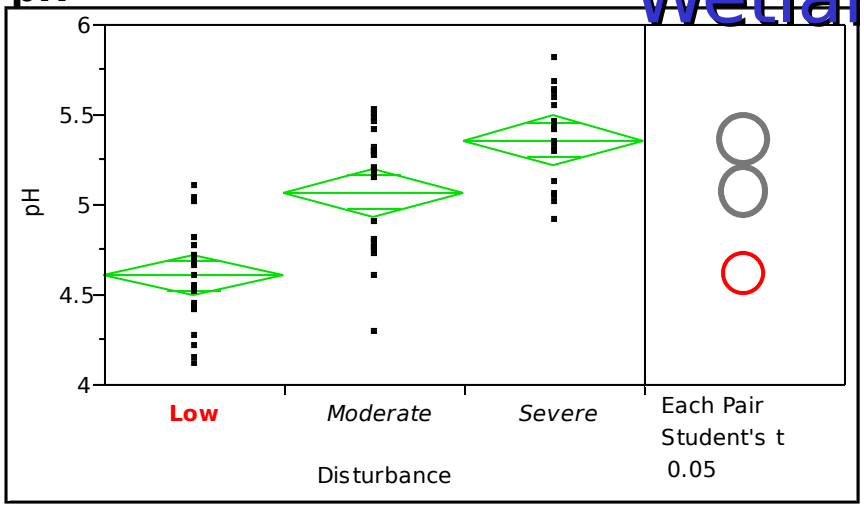
Characterize central tendencies and spatio-temporal variability:

- “homogeneous” sites
- gradients of military use
- land management gradients

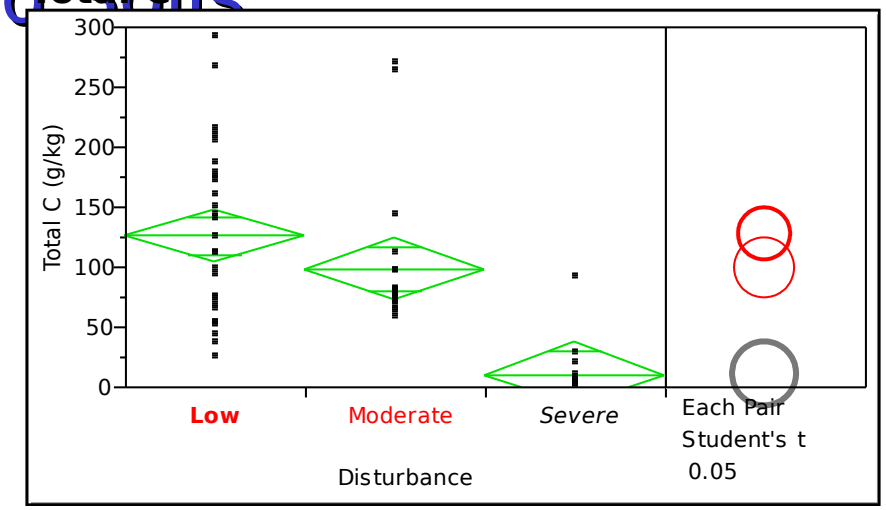
SOIL BIOGEOCHEMISTRY – TRANSECTS (Phase 2)

Wetland Soils

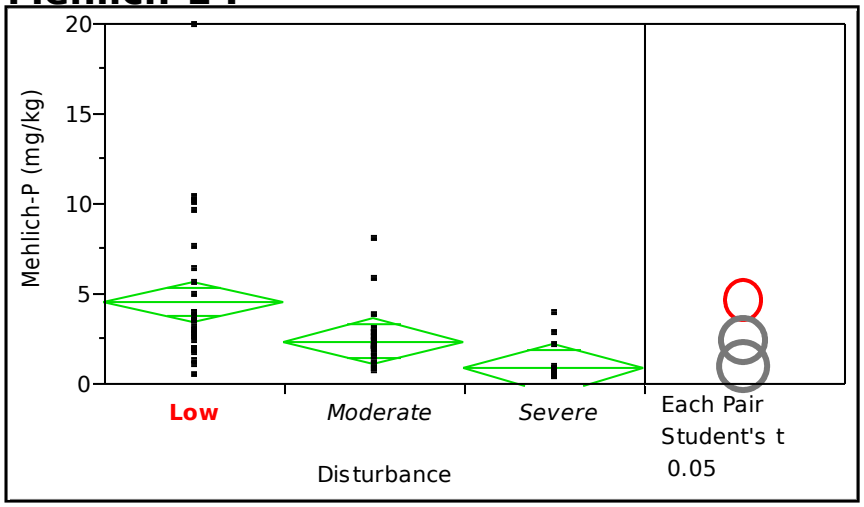
pH



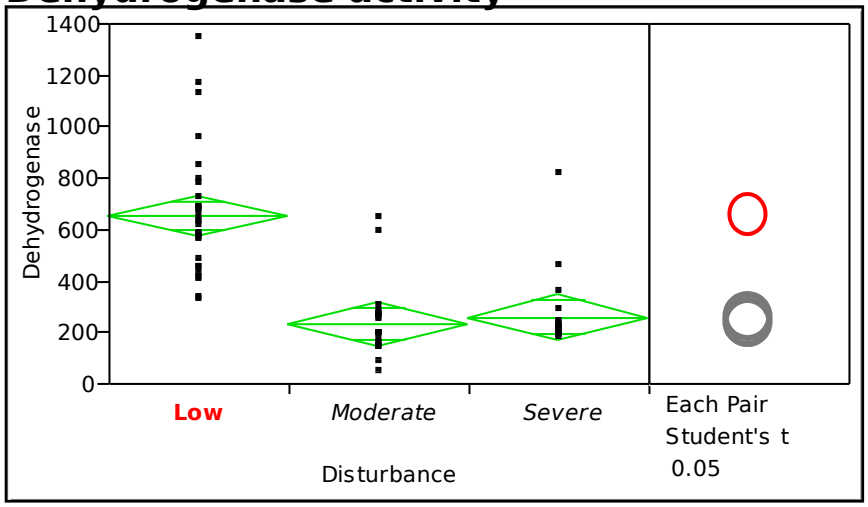
Total C



Mehlich-1 P

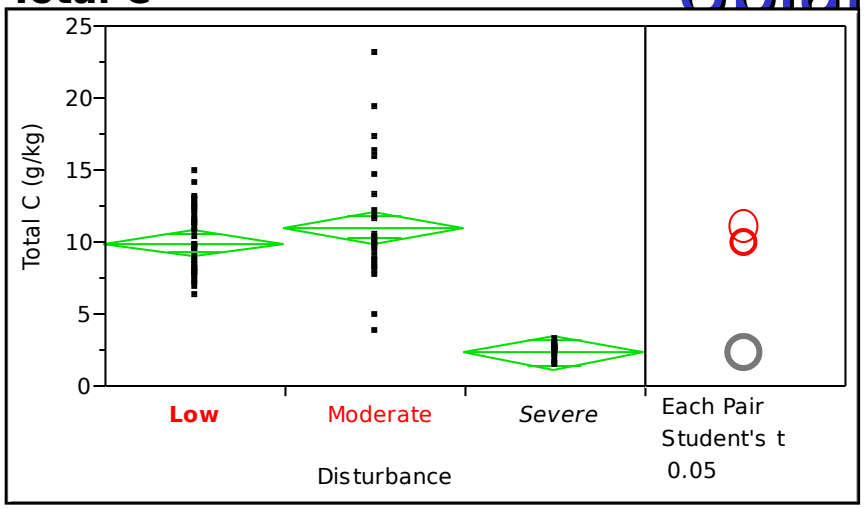


Dehydrogenase activity

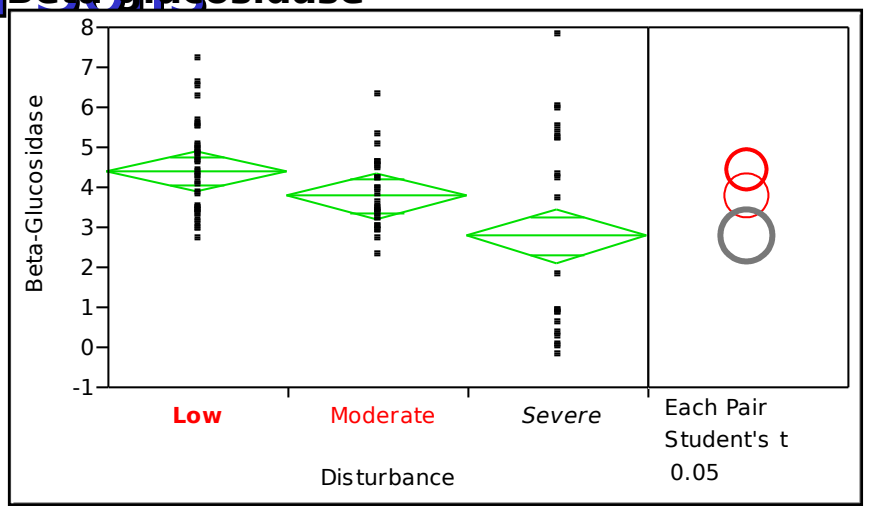


SOIL BIOGEOCHEMISTRY – TRANSECTS (Phase 2) Upland Soils

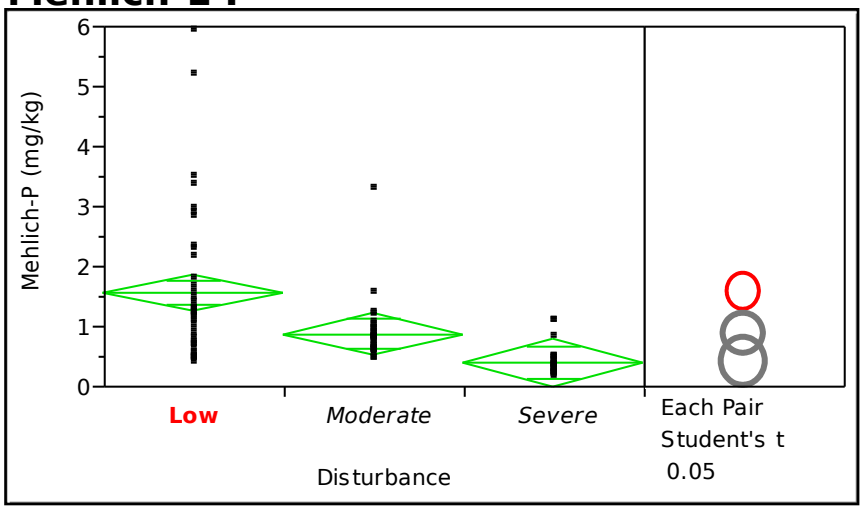
Total C



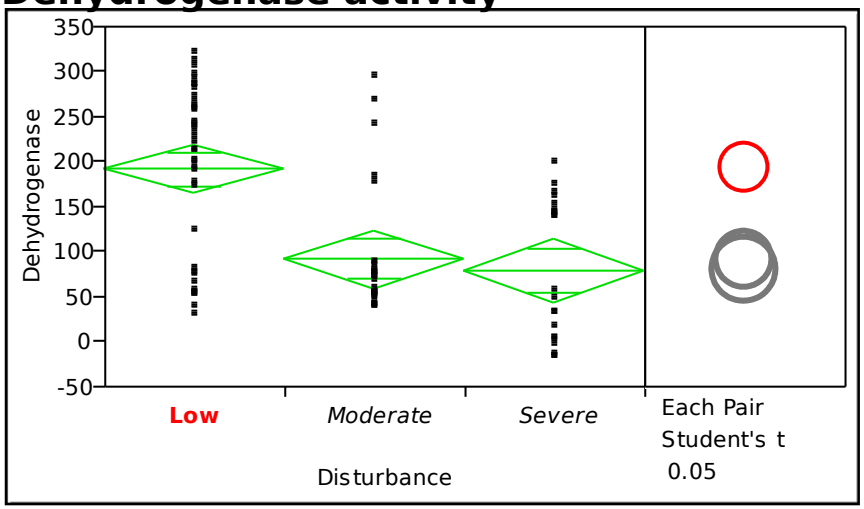
Beta glucosidase



Mehlich-1 P

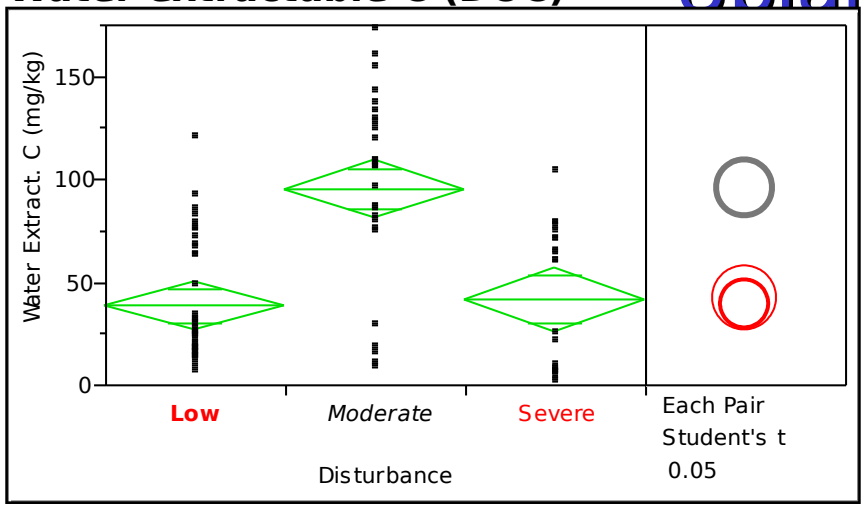


Dehydrogenase activity

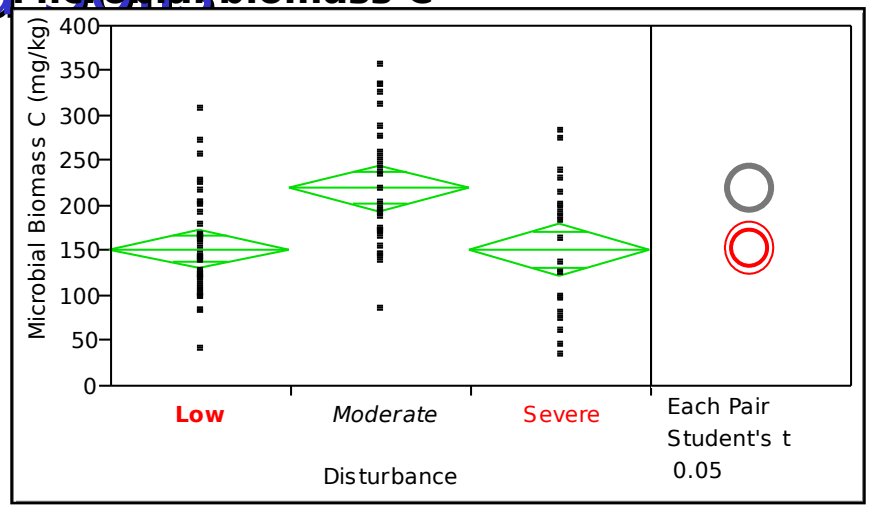


SOIL BIOGEOCHEMISTRY – TRANSECTS (Phase 2) Upland Soils

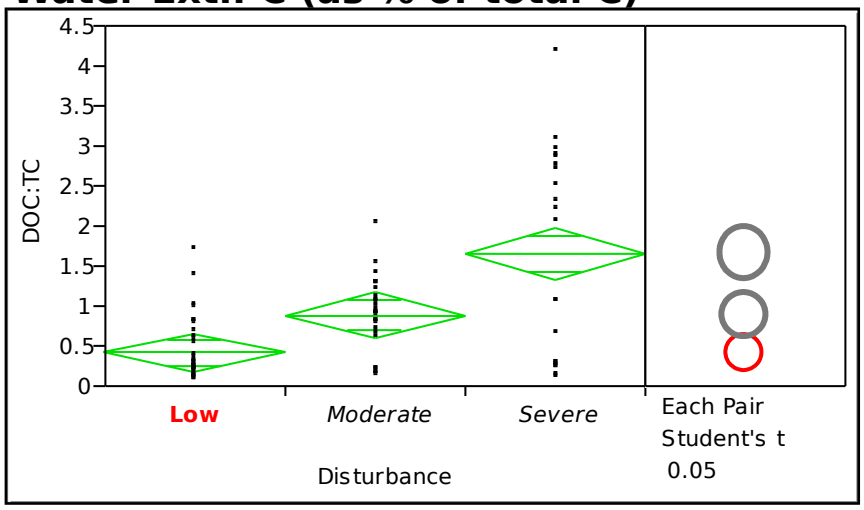
Water extractable C (DOC)



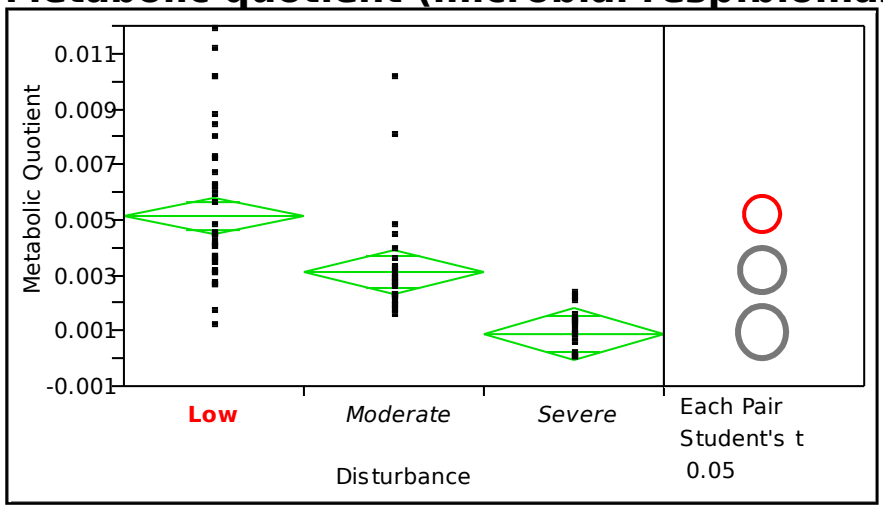
Microbial biomass C



Water Extr. C (as % of total C)



Metabolic quotient (microbial resp:biomass)



SOIL MICROBIAL DIVERSITY

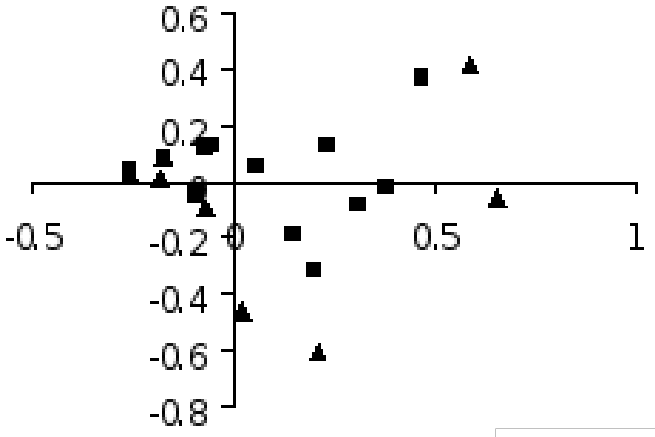
T-RFLP Analysis

(Terminal Restriction Fragment Polymorphism Analysis)

- Method to “fingerprint” 16S rRNA gene
- Visualization of different genotypes
- Electropherogram peak differentiation and relative peak size (relate to different genotypes and relative concentrations)
- Evaluate functional groups of methanotrophic bacteria
  - Oxidize methane as carbon energy source under high methane, low O_2 conditions (e.g. in wetlands)

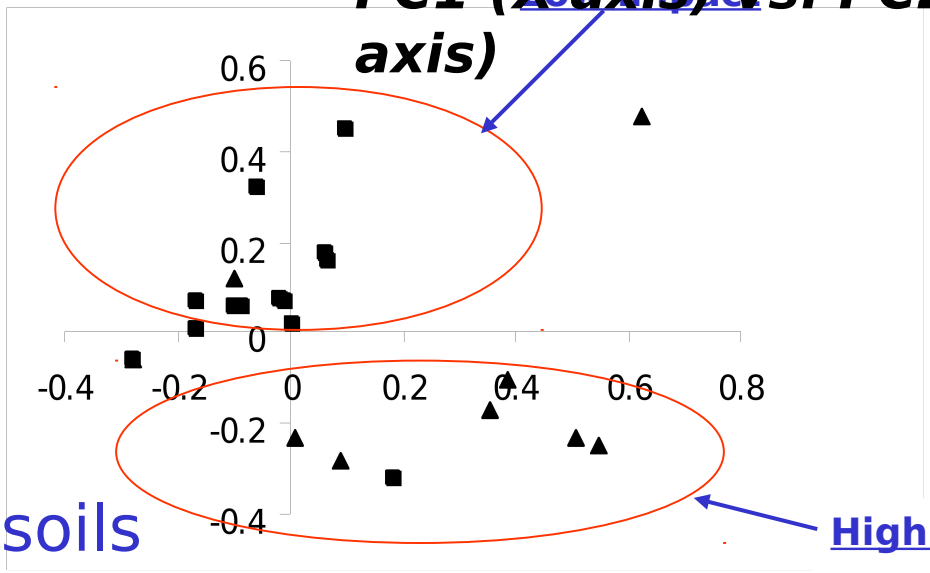
SOIL MICROBIAL DIVERSITY

- PCA discrimination of 4 soils based on methanotroph assemblage composition



Upland soils

- ***PC1 (X-axis) vs. PC2 (Y-axis)***



Wetland soils

VEGETATION – Phase 1

- Total of 273 sites (Phase 1 soil sampling sites)
- Structure & Composition of Vegetation:

  Woody plants canopy cover <2m tall along three 5-m transects

  Overstory canopy cover (densiometer)

  Herbaceous understory cover, density, and biomass in three $1m^2$ quadrats (only measured at the triplicate soil testing sites, n=56 sites)

- Environmental Variables:

  Site position – upland, slope, or bottom

  Soil texture – sand, loam, sand/loam, clay, sand/clay, or organic

  Disturbance – low, moderate, severe

VEGETATION – Phase 1

Canonical Correspondence Analysis (CCA)

- an ordination technique
- relates vegetation variables to environmental var
- biplots reveal patterns among the variables

VEGETATION – Phase 1
Woody Species

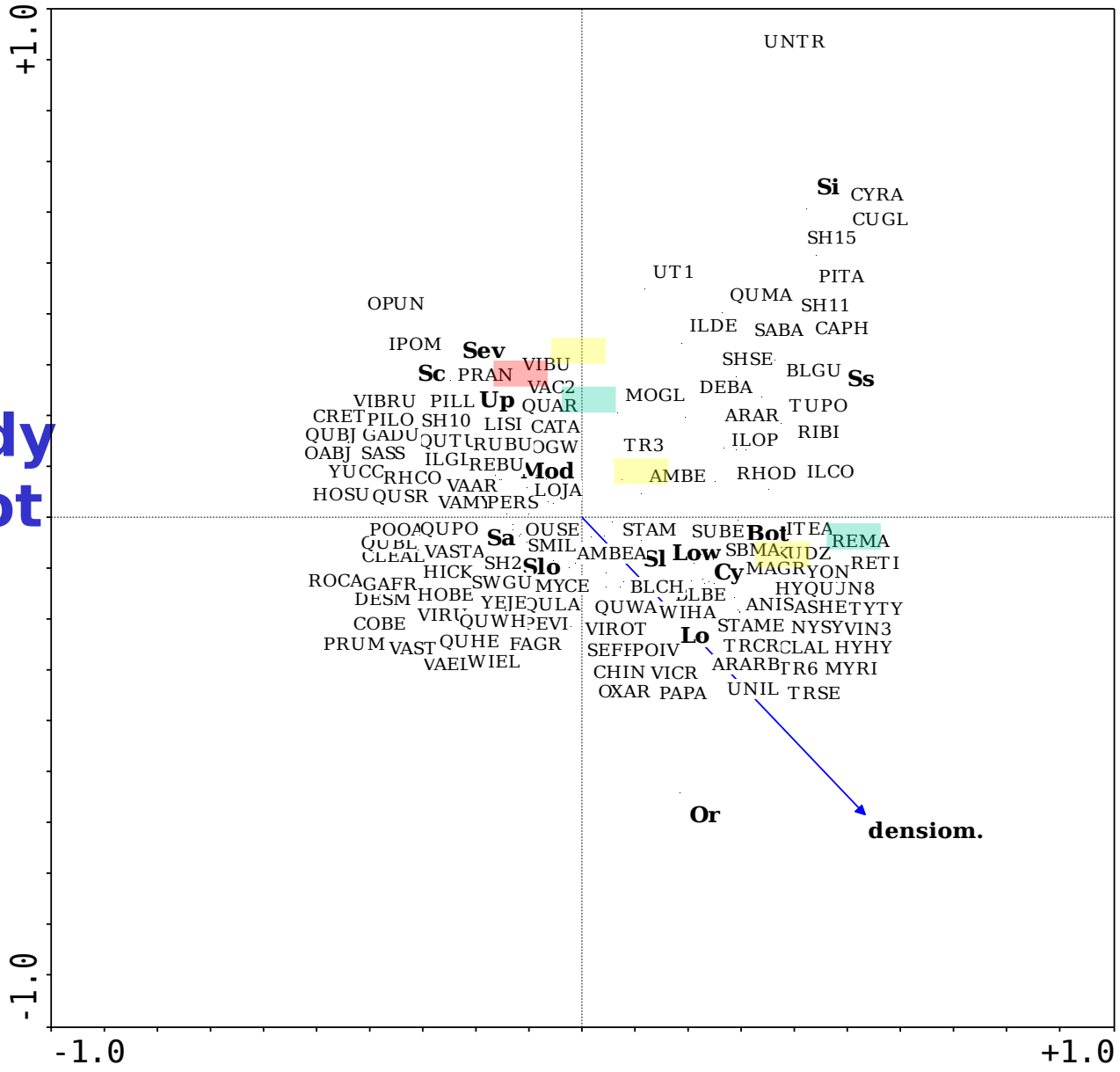
113 total woody species encountered

Biplot shows:

- Low (Lo) disturbance sites are separated from moderate (Mod) and s
- Severe disturbance sites are closely associated with upland (Up), sand
- ⇑overstory canopy cover is associated with low disturbance sites

VEGETATION – Woody Species

Woody Biplot



VEGETATION – Phase 1
Herbaceous Species

110 total herbaceous species encountered

Biplot shows:

- most herbaceous species were encountered in the upland and slopes, t
  omitted from the CCA biplot

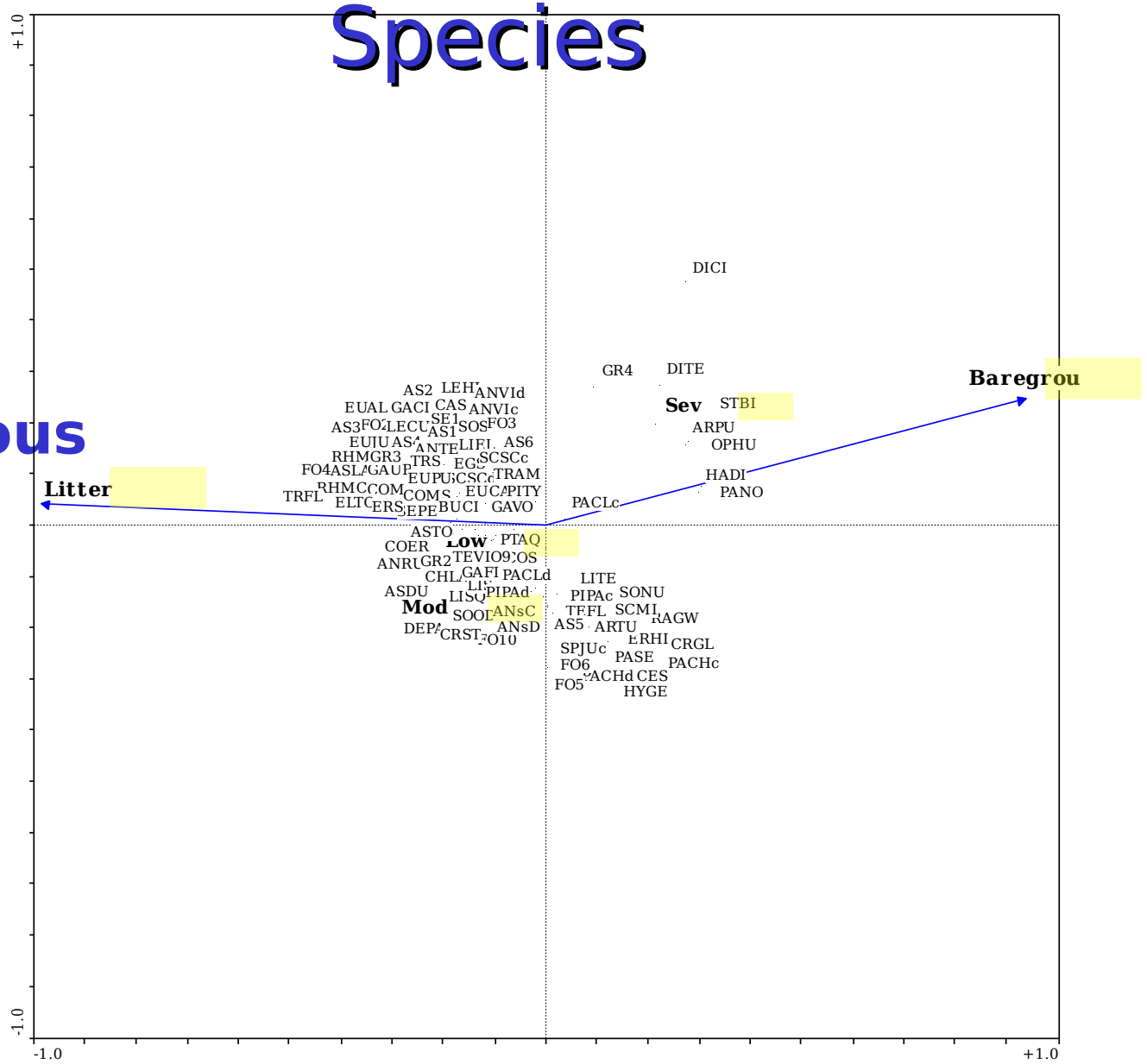
- Severe disturbance sites are clearly separated from low and moderate

- Subset of herb. species cover is correlated with severe disturbance:

Digitaria ciliaris	southern crab grass
Diodia teres	poor joe
Stylosanthes biflora	pencil flower
Aristida Purpurescens	arrow feather
Opuntia humifusa	prickly pear cactus
Haplopappus dirasicatus	scratch daisy
Paspalum notatum	bahia grass

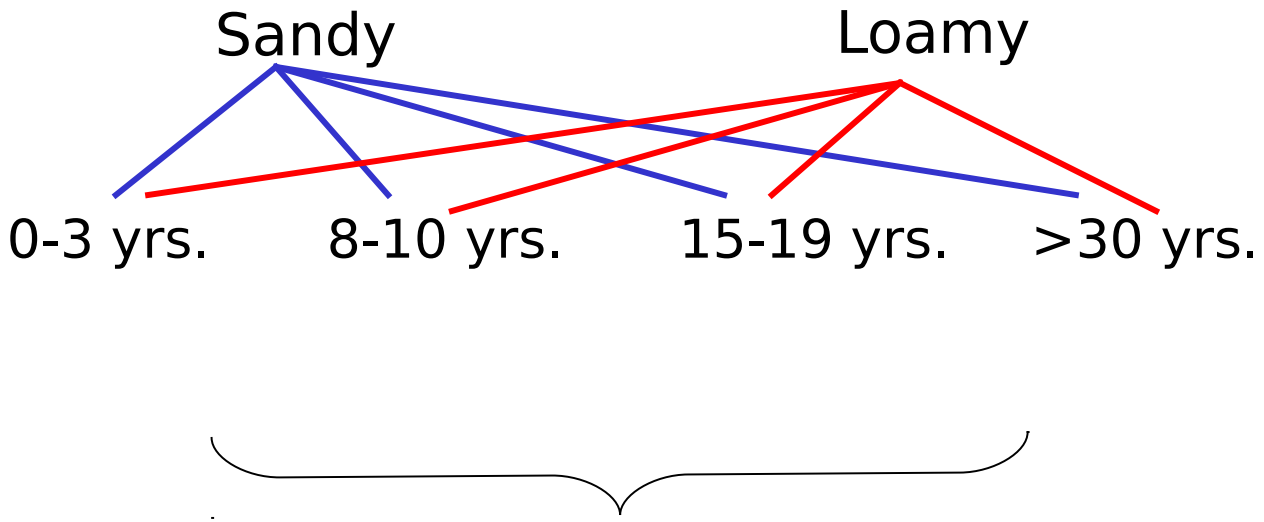
VEGETATION – Herbaceous Species

Herbaceous Biplot



VEGETATION – PHASE 2

Silviculture Impacts on Sandy and Loamy Soils: Chronosequence Study



32 Sites: 4 sites in each age group in each soil type

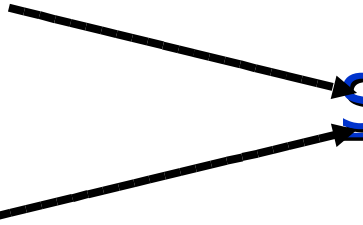
ANTICIPATED PRODUCTS

Watershed models
Stream
flow/chemistry

Watershed assessment

Vegetation cover, species

Soil physical, biological, chemical properties



Site assessment